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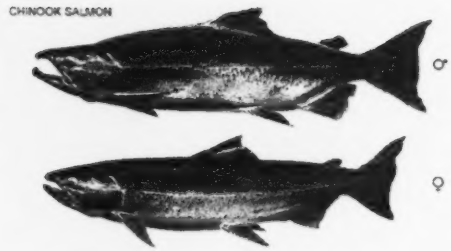
Canadian Science Advisory Secretariat
Science Advisory Report 2011/019

OPTIMUM ESCAPEMENT GOALS FOR CHINOOK SALMON IN THE TRANSBOUNDARY ALSEK RIVER



Chinook salmon adult spawning phase. DFO website.

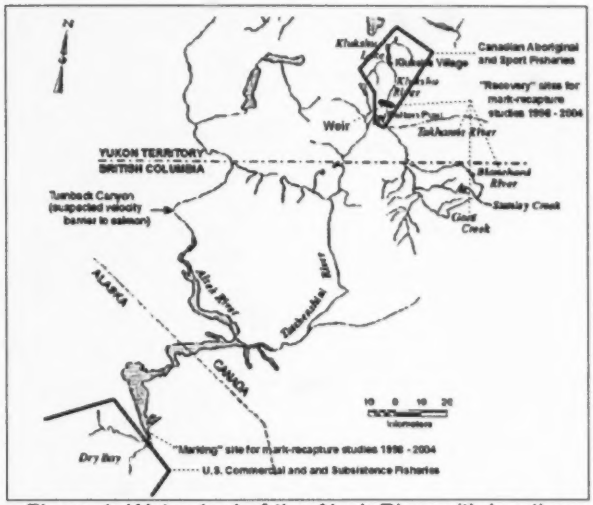


Figure 1: Watershed of the Alsek River with locations of fisheries and sampling identified

Context:

The Alsek River is considered a "transboundary" system; one which rises in Canada and flows to the ocean through the United States. Management of salmon originating in the Alsek River is through agreements outlined in the Transboundary chapter (Annex IX) of the Pacific Salmon Treaty (PST). Biologically based escapement goals form the basis for management decisions related to transboundary stocks.

The current PST has an escapement goal range of 1,100 to 2,300 Chinook salmon spawning in the Klukshu River was produced in 1998, using a method of minimizing expected loss in yield. The PST Transboundary agreement (2010) commits to establishing updated biologically based escapement goals for both the Alsek and its tributary, the Klukshu River; and to review of the proposed escapement goals by both the Transboundary technical committee and the Salmon Standing Committee of the Centre for Science Advice Pacific (CSAP).

This Science Advisory Report has resulted from a Fisheries and Oceans Canada, Canadian Science Advisory Secretariat Pacific Regional Advisory Process. Additional publications resulting from this process will be posted as they become available on the DFO Science Advisory Schedule at http://www.dfo-mpo.gc.ca/csas-sccs/index-eng.htm.

Canada

SUMMARY

- The Alsek River Chinook stock is considered a single Conservation Unit under the Wild Salmon Policy. Management of this stock is conducted bilaterally through the Pacific Salmon Treaty.
- The Salmon Standing Committee of the Centre for Science Advice Pacific (CSAP) was presented with updated analysis and results conducted by the Alaskan Department of Fish and Game (ADF&G) regarding the optimal escapement goal for Alsek River Chinook.
- Escapement analysis incorporated stock assessment data from 1976 to 2007, and included seven years of radio-telemetry and mark-recapture studies. Data and methods in the current analysis are considered an improvement over methods employed previously, and take into account known sources of uncertainty.
- Overall, this analysis represents an improvement over methods used previously to determine escapement goals for these stocks and is endorsed for the provision of advice for the establishment of escapement goals for the Alsek and Klukshu Rivers.
- Escapement goal ranges of 3,520 to 5,280 adults for the Alsek River and 800 to 1,200 adults for the Klukshu River were recommended. These escapement ranges represented a 90-98% chance of achieving at least 90% of Maximum Sustainable Yield (MSY) from these stocks.
- Given the incorporation of uncertainty in stock assessment data and the robust approach used to provide advice on the establishment of escapement goals, it is recommend that the methods used in this assessment be considered when providing escapement goal advice for other Canadian systems, where appropriate given the data available.

BACKGROUND

The Alsek River drains approximately 19,000 km^2 of Alaska and Canada into the Gulf of Alaska at 59° 11′ N 138° 29′ W (Figure 1). The river is home to all five species of Pacific salmon. Runs of Chinook and sockeye (*O. nerka*) salmon overlap, entering the river earlier in May and June. Commercial and subsistence fisheries occur in the intertidal area of the Alsek River, in the marine waters of Dry Bay adjacent to the river, and target both Chinook and sockeye salmon in set gillnets. Hook-and-line sport and aboriginal fisheries occur in Canada in the Klukshu River, and upstream of Dalton Post. Timing of nearby fisheries and recovery of coded wire tags implanted in smolts from the Alsek River indicate that significant harvest has been limited to terminal fisheries on the Alsek stock (McPherson et al. 1998).

Chinook salmon spawn almost exclusively in the Tatshenshini River and its tributaries. Chinook salmon smolt exclusively at age 1.0 (2-year olds) and return predominantly at ages 1.2 (4-year olds), 1.3 (5-year olds), and 1.4 (6-year olds).

Stock assessment has been focused on the Klukshu River. A weir was installed in 1976, and all migrants were enumerated annually. In most years, catches in all fisheries, fish passing through the weir, and dead and moribund fish on spawning grounds were sampled for biological data. In 1998, test fishing using drift gillnets began in the river upstream of commercial and subsistence fisheries in Dry Bay. Radio-telemetry studies conducted between 1998 and 2004 were used to generate annual in-river run size estimates.

Rationale for Assessment

The current PST has an escapement goal range of 1,100 to 2,300 Chinook salmon spawning in the Klukshu River, and was produced in 1998, using a method of minimizing expected loss in yield. The PST Transboundary agreement (2010) commits to establishing updated biologically based escapement goals for both the Alsek and its tributary the Klukshu River; and to review of the proposed escapement goals by both the Transboundary technical committee and the Salmon Standing Committee of the Centre for Science Advice Pacific (CSAP).

ANALYSIS

The objectives of this analysis were to 1) develop estimates (and variances) of annual runs, annual spawning abundance, and brood-year production for the aggregate stock of Chinook salmon in the Alsek River, and 2) use these statistics to determine a suite of escapement goals that are likely to produce optimum yield (maximum or nearly maximum sustained yield) from the Alsek stock. This work is an update of an earlier analysis (McPherson et al. 1998) to determine escapement goals for Chinook salmon spawning in the Klukshu River, a tributary of the Alsek River. Escapement goals from the analysis in McPherson et al. (1998) have been expanded to cover the aggregate stock for the entire drainage of the Alsek River and to include 11 years of additional data.

Bayesian statistical analysis was used on estimates for harvest, in-river run size, harvest rates, relative age composition, and escapements for calendar years 1976 through 2007 to determine optimum escapement goals for the Alsek Chinook stock. Bayesian analysis was chosen because 1) information on relative age composition is missing for some years, 2) estimates of spawning abundance contain considerable measurement error, and 3) such an analysis provides an expression of the uncertainty associated with the chosen escapement goal.

This expression of uncertainty is in the form of posterior probability distributions for parameters and variables given the observations of the Alsek stock made since 1976. Observations (estimates and data) are considered known without error in a Bayesian analysis, while rates and variables defining states are considered to be unknown, but with an uncertainty expressible through probability distributions. Bayesian analysis also allowed for the incorporation of knowledge on the productivity of Chinook salmon stocks in general in determining escapement goals for the Alsek stock.

Simulations resulted in a posterior distribution for *Smsy* (spawning abundance needed to produce maximum sustained yield) with a mean of 4,677 and a median of 4,433 adults for the Alsek stock. Posterior distributions for *Smsy* for the Klukshu stock had a mean of 999 and a median of 979 adults. Yield profiles created from simulation results were calculated for both stocks. These profiles are used to illustrate the chance of attaining optimal yield with a specific escapement as a goal. Profiles were created for optimum yield defined as 60, 70, 80 and 90 percent or better of MSY. The 90% yield curve resulted in a spawning escapement range of 3,520 to 5,280 adults for the Alsek River and 800 and 1,200 spawning adults for the Klukshu Rivers (Figure 2 and Figure 3).

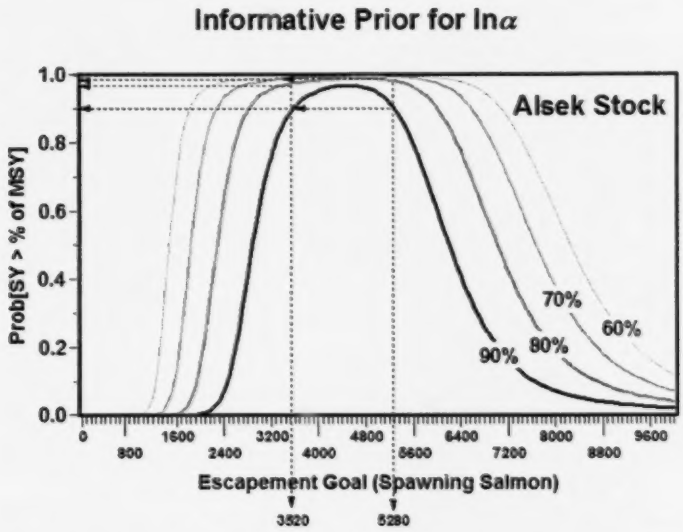


Figure 2. Optimum yield (OY) profiles for the Alsek stock of Chinook salmon based on a Bayesian analysis. Each dashed line connects the chance of attaining OY with a specific escapement as a goal. Profiles are provided for optimum yields that are at least 60%, 70%, 80%, or 90% of MSY.

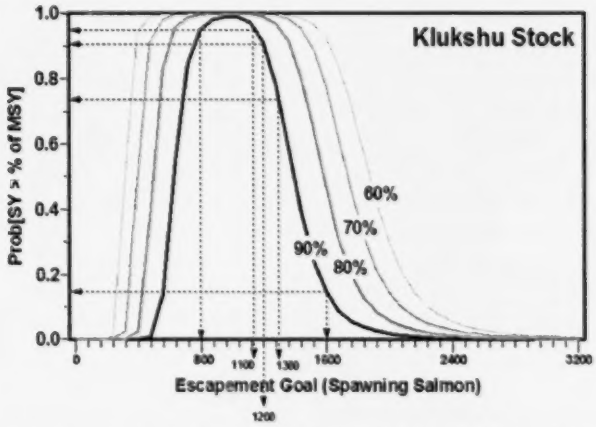


Figure 3. Optimum yield (OY) profiles for the Klukshu stock of Chinook salmon based on a Bayesian analysis. Each dashed line connects the chance of attaining OY with a specific escapement as a goal. Profiles are provided for optimum yields that are at least 60%, 70%, 80%, or 90% of MSY.

CONCLUSIONS AND ADVICE

The Bayesian statistical analysis based on estimates for harvest, in-river run size, harvest rates, relative age composition, and escapements for calendar years 1976 through 2007, for the Alsek and Klukshu Rivers is comprehensive and robust in providing escapement goals and probability distributions for *Smsy*. The analysis of data resulted in a posterior distribution for *Smsy with* a mean of 4,677 adults and a median of 4,433 adults for the Alsek stock. Posterior distributions

for *Smsy* for the Klukshu stock had a mean of 999 adults and a median of 979 adults. The analysis takes advantage of a longer time series of catch and escapement data than was previously available, and of data provided by mark-recapture and radio telemetry studies.

The analysis takes into account and incorporates known sources of uncertainty. The approach taken is flexible in that other definitions of optimal yield can be addressed with little adjustment. Overall, this analysis represents an improvement over methods used previously to determine escapement goals for these stocks and is endorsed for the provision of advice for the establishment of escapement goals for the Alsek and Klukshu Rivers.

While the research document reviewed recommends adopting the yield curve based on an optimal yield that is 90% or better of MSY, there is no analytical or biological basis on which to recommend this curve over any other. The choice of which yield curve to use is left to the discretion of Fisheries Management.

Given the incorporation uncertainty in stock assessment data and the robustness of the approach used to provide advice on the establishment of escapement goals, it is recommend that the methods used in this assessment be considered when providing escapement goal advice for other Canadian systems, where appropriate given the data available.

OTHER CONSIDERATIONS

Data sources, methods and results reviewed though this Canadian Science Advisory Secretariat Regional Advisory Process are based on the work published by the Alaskan Department of Fish and Game and reviewed and approved by the bilateral CTC in February 2010. The State of Alaska has adopted escapement goals and optimal escapement ranges presented in this assessment with optimum yield being at least 90% of MSY.

SOURCES OF INFORMATION

This Science Advisory Report has resulted from a Fisheries and Oceans Canada, Canadian Science Advisory Secretariat Pacific Regional Advisory Process of October 18-19, 2010 on Assessment of Escapement Goals for Alsek River Chinook and Sockeye and Taku River Chinook and Coho. Additional publications resulting from this process will be posted as they become available on the DFO Science Advisory Schedule at http://www.dfo-mpo.gc.ca/csas-sccs/index-eng.htm.

McPherson, S. A., P. Etherton, and J. H. Clark. 1998. Biological escapement goal for Klukshu River Chinook salmon. Alaska Department of Fish and Game, Fishery Manuscript No. 98-2, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fms98-02.pdf

Bernard, D. R., and E. L. Jones III. 2010. Optimum escapement goals for Chinook salmon in the transboundary Alsek River. Alaska Department of Fish and Game, Fishery Manuscript Series No. 10-02, Anchorage. http://www.adfg.alaska.gov/FedAidPDFs/FMS10-02.pdf

FOR MORE INFORMATION

Contact: David R. Bernard
D. R. Bernard Consulting
6801 Sky Circle,
Anchorage, Alaska, 99502-3979, USA
Tel: 907-334-9005
Fax: 907-334-9005
E-Mail: drbernardconsulting@gci.net

Contact: Michael Chamberlain
Fraser River Stock Assessment, CDFO
985 McGill Place,
Kamloops, BC V2C 6X6

Tel: 250-851-4947
Fax: 250-851-4951
E-Mail: Michael.Chamberlain@dfo-mpo.gc.ca

This report is available from the:

Centre for Science Advice (CSA)
Pacific Region
Fisheries and Oceans Canada
Pacific Biological Station
3190 Hammond Bay Road
Nanaimo, BC V9T 6N7

Telephone: 250-756-7208
Fax: 250-756-7209
E-Mail: CSAP@dfo-mpo.gc.ca
Internet address: www.dfo-mpo.gc.ca/csas-sccs

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